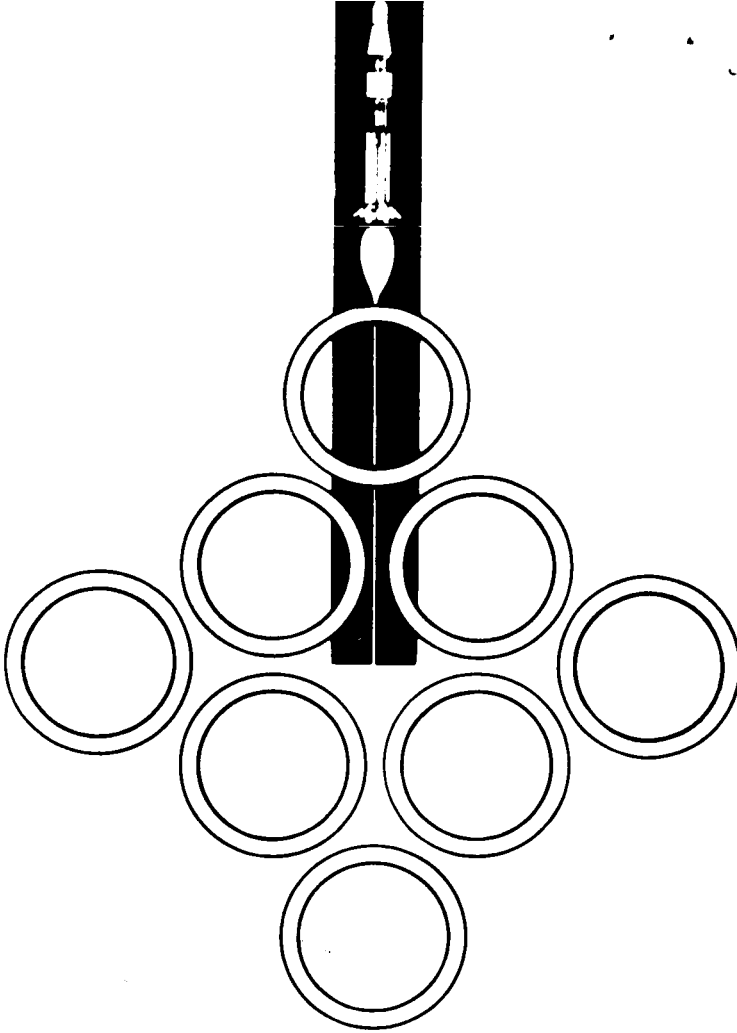


ENGINEERING DEPARTMENT
TECHNICAL REPORT

TR-RE-CCSD-FO-1130-3

May 23, 1967



SATURN IB PROGRAM

TEST REPORT
FOR

SOLENOID VALVE, 3/8-INCH, 3-WAY

Flodyne Controls, Inc., Part Number 3A37S

NASA Drawing Number 10425701-2

N67-36797

(ACCESSION NUMBER)

(THRU)

(PAGES)

(CODE)

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FACILITY FORM 602

SPACE DIVISION



CHRYSLER
CORPORATION

TEST REPORT

FOR

SOLENOID VALVE, 3/8-INCH, 3-WAY

Flodyne Controls Inc., Part Number 3A37S

NASA Drawing Number 10425701-2

ABSTRACT

This report presents the results of tests performed on three specimens of Solenoid Valve 10425701-2. The following tests were performed:

- | | |
|-------------------------|---------------------|
| 1. Receiving Inspection | 4. High Temperature |
| 2. Proof Pressure | 5. Low Temperature |
| 3. Functional | |

The three specimens did not perform in accordance to the specification requirements of NASA Drawing 10425701-2. The specimens were returned to the vendor for reworking after excessive leakage and switch malfunctions during the initial functional test. After the specimens were reworked, testing was resumed. The specimens again failed to meet specification requirements because of excessive leakage and the tests were discontinued.

TR-RE-CCSD-FO-1130-3

TEST REPORT

FOR

SOLENOID VALVE, 3/8-INCH, 3-WAY

Flodyne Controls Inc., Part Number 3A37S

NASA Drawing Number 10425701-2

May 23, 1967

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS 8-4016, Part VII, CWO 271620.

TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
I	INTRODUCTION	1-1
II	RECEIVING INSPECTION	2-1
III	PROOF PRESSURE TEST.	3-1
IV	FUNCTIONAL TEST	4-1
V	LOW TEMPERATURE TEST	5-1
VI	HIGH TEMPERATURE TEST	6-1

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Page</u>
FRONTISPIECE	vii
2-1 RECEIVING INSPECTION	2-3
3-1 PROOF PRESSURE TEST SCHEMATIC	3-3
3-2 PROOF PRESSURE TEST SETUP.	3-4
4-1 FUNCTIONAL TEST SCHEMATIC.	4-35
4-2 FUNCTIONAL TEST SETUP.	4-36
5-1 LOW AND HIGH TEMPERATURE TEST SETUP.	5-9

LIST OF TABLES

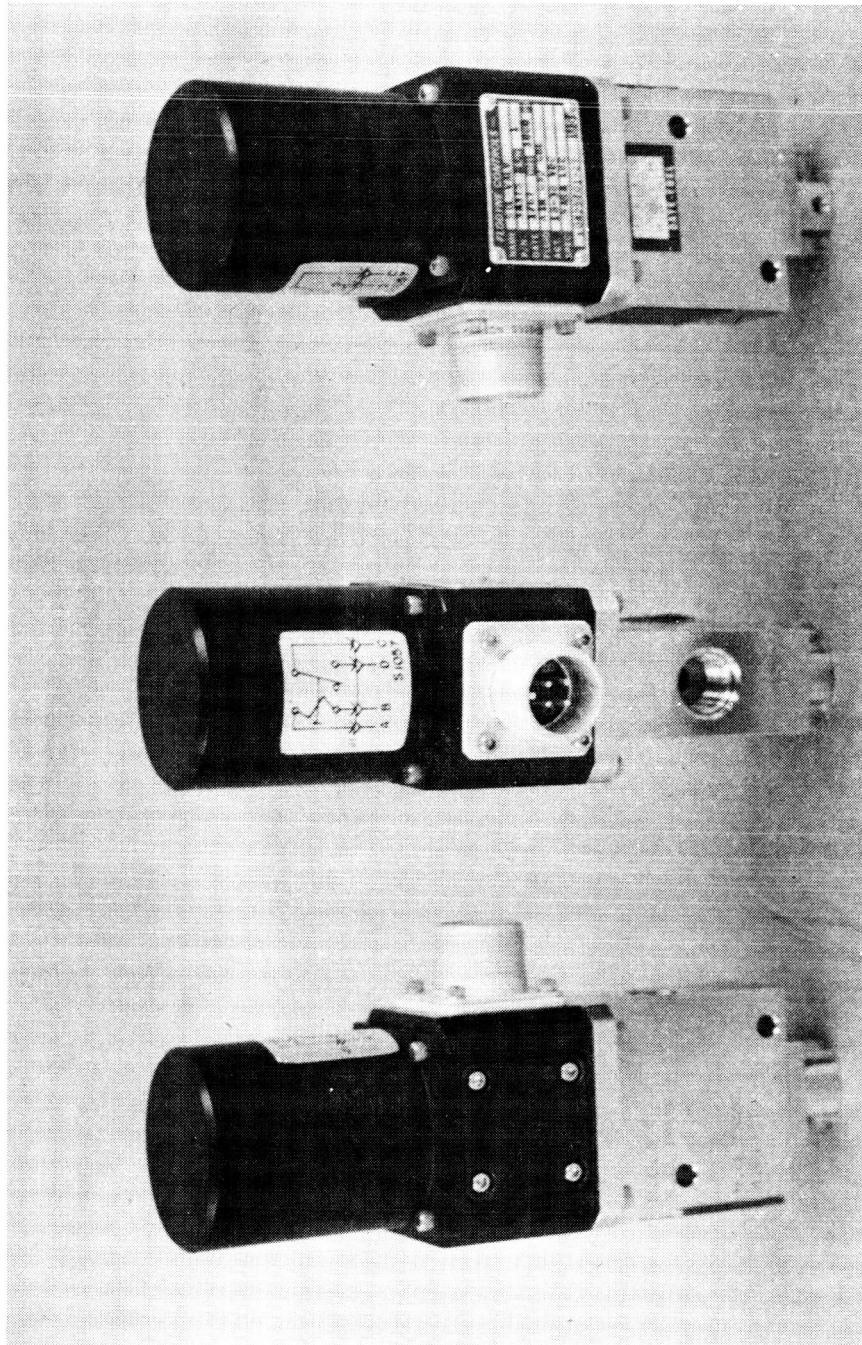
<u>Table</u>	<u>Page</u>
2-1 RECEIVING INSPECTION TEST DATA	2-2
2-2 RECEIVING INSPECTION TEST EQUIPMENT LIST	2-2
3-1 PROOF PRESSURE TEST EQUIPMENT LIST	3-2
3-2 LEAKAGE DATA WITH INLET AND OUTLET PORTS SIMULTANEOUSLY PRESSURIZED	3-2
4-1 FUNCTIONAL TEST EQUIPMENT LIST	4-4
4-2 INITIAL INSULATION AND RESISTANCE FUNCTIONAL TEST DATA (SPECIMEN)	4-6
4-3 INITIAL FUNCTIONAL TEST DATA (SPECIMEN 1).	4-7
4-4 FUNCTIONAL INSULATION AND RESISTANCE TEST DATA AFTER VENDOR REWORK (SPECIMEN 1)	4-9
4-5 FUNCTIONAL TEST DATA AFTER VENDOR REWORK (SPECIMEN 1).	4-10
4-6 FUNCTIONAL INSULATION AND RESISTANCE TEST AFTER 72 HOUR DELAY PRIOR TO LOW TEMPERATURE TEST (SPECIMEN 1).	4-12
4-7 FUNCTIONAL TEST DATA AFTER 72 HOUR DELAY PRIOR TO LOW TEMPERATURE TEST (SPECIMEN 1).	4-13
4-8 FUNCTIONAL TEST DATA AFTER NEW SPRING INSTALLATION (SPECIMEN 1)	4-14

LIST OF TABLES (Continued)

<u>Table</u>		<u>Page</u>
4-9	INITIAL INSULATION AND RESISTANCE FUNCTIONAL TEST DATA (SPECIMEN 2)	4-16
4-10	INITIAL FUNCTIONAL TEST DATA (SPECIMEN 2)	4-17
4-11	FUNCTIONAL INSULATION AND RESISTANCE TEST DATA AFTER VENDOR REWORK (SPECIMEN 2)	4-18
4-12	FUNCTIONAL TEST DATA AFTER VENDOR REWORK (SPECIMEN 2)	4-19
4-13	FUNCTIONAL INSULATION AND RESISTANCE TEST DATA AFTER 72 HOUR DELAY PRIOR TO LOW TEMPERATURE TEST (SPECIMEN 2)	4-21
4-14	FUNCTIONAL TEST DATA AFTER 72 HOUR DELAY PRIOR TO LOW TEMPERATURE TEST (SPECIMEN 2)	4-22
4-15	FUNCTIONAL INSULATION AND RESISTANCE TEST DATA AFTER VALVE ADJUSTMENT (SPECIMEN 2)	4-24
4-16	FUNCTIONAL TEST DATA AFTER VALVE ADJUSTMENT (SPECIMEN 2)	4-25
4-17	INITIAL INSULATION AND RESISTANCE FUNCTIONAL TEST DATA (SPECIMEN 3)	4-27
4-18	INITIAL FUNCTIONAL TEST DATA (SPECIMEN 3)	4-28
4-19	FUNCTIONAL INSULATION AND RESISTANCE TEST AFTER VENDOR REWORK (SPECIMEN 3)	4-29
4-20	FUNCTIONAL TEST DATA AFTER VENDOR REWORK (SPECIMEN 3)	4-30
4-21	FUNCTIONAL INSULATION AND RESISTANT TEST DATA AFTER 72 HOUR DELAY (SPECIMEN 3)	4-32
4-22	FUNCTIONAL TEST DATA AFTER 72 HOUR DELAY (SPECIMEN 3)	4-33
5-1	FUNCTIONAL INSULATION AND RESISTANCE TEST DATA DURING LOW TEMPERATURE TEST (SPECIMEN 2)	5-3
5-2	FUNCTIONAL TEST DATA DURING LOW TEMPERATURE TEST (SPECIMEN 2)	5-4
5-3	FUNCTIONAL TEST DATA DURING A REQUESTED TEMPERATURE OF 20 (+0,-4)°F (SPECIMEN 2)	5-6

LIST OF TABLES (Continued)

<u>Table</u>		<u>Page</u>
5-4	FUNCTIONAL TEST DATA AT ROOM AMBIENT CONDITIONS FOLLOWING THE LOW TEMPERATURE TEST (SPECIMEN 2). . . .	5-8
6-1	FUNCTIONAL INSULATION AND RESISTANCE TEST DATA DURING HIGH TEMPERATURE TEST (SPECIMEN 3).	6-3
6-2	FUNCTIONAL TEST DATA DURING HIGH TEMPERATURE TEST (SPECIMEN 3).	6-4
6-3	FUNCTIONAL TEST DATA AT ROOM AMBIENT CONDITIONS FOLLOWING THE LOW TEMPERATURE TEST (SPECIMEN 3). . . .	6-5



Solenoid Valves 10425701-2, 3/8-inch, 3-way

CHECK SHEET

FOR

SOLENOID VALVE, 3/8-INCH, 3-WAY

MANUFACTURER: Flodyne Controls, Inc.

MANUFACTURER'S PART NUMBER: 3A37S

NASA DRAWING NUMBER: 10425701-2

TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana

AUTHORIZING AGENCY: NSAS KSC

I. FUNCTIONAL REQUIREMENTS

- | | |
|------------------------|---------------------------------------------------------------------------------------|
| A. OPERATING MEDIA: | Dry air, gaseous nitrogen, gaseous helium |
| B. OPERATING PRESSURE: | 3000 psig |
| C. PROOF PRESSURE: | 4500 psig |
| D. COIL OPERATION: | 18-30 vdc, 1.33-amp at 24 vdc and 68°F |
| E. LEAKAGE: | Internal - not to exceed 5 scim within.
Working pressures external - bubble tight. |

II. CONSTRUCTION

- | | |
|-------------------|---------------------|
| A. BODY MATERIAL: | 316 stainless steel |
| B. ORIFICE: | 0.189-inch diameter |
| C. PORT FITTING: | MC 204-6 |
| D. SEAL: | KEL-F |

III. ENVIRONMENTAL CHARACTERISTICS

The temperature range shall be 0 to 160°F.

IV. LOCATION AND USE:

The solenoid valve is located in the pneumatic distribution system valve panel 2 at Launch Complex 37B and provides backup closing control to the LOX prevalues. It is also used at numerous other locations at Launch Complexes 34 and 37B.

TEST SUMMARY
SOLENOID VALVE 10425701-2
AFTER VENDOR REWORKED SPECIMEN 1, 2 AND 3

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Receiving Inspection	1,2,3	Drawings and Specifications	To determine specimen conformance with drawings and specifications	Satisfactory	
Proof Pressure Test	1,2,3	4500 psig	To check for leakage and distortion	Satisfactory	Zero leakage
Functional Test	1,2,3	3000 psig	Check leakage Insulation resistance Pull in voltage Drop out voltage Coil current Response time	Failure Specimen 1 leaked 1260 scim at 3000 psig Specimens 2 and 3 Satisfactory	Internal 5 scim (max) 20 Megohms (min) Determine Determine 1.33 amp at 24 vdc '65 milliseconds at 3000 psig and 28 vdc.
Low Temperature Test	2	0(+0,-4)*F Temperature change rate 1°F per minute	To determine if specimen operation is impaired by low temperature	Failed: Leakage exceeded 1400 scim. Response time 101 milliseconds	Perform a functional test at this temperature
High Temperature Test	3	160(+5,-0)*F Relative Humidity of 20(+5) percent	To determine if specimen operation is impaired by high temperature	Failed: Leakage exceeded 4500 scim at 3000 psig	Perform a functional test at this temperature
Flow Test		Testing discontinued due to failure of specimens 1, 2 and 3			
Vibration Test					
Explosion Test					
Humidity Test					
Sand and Dust Test					

TEST SUMMARY
SOLENOID VALVE 10425701-2
AFTER VENDOR REWORKED SPECIMEN 1, 2 AND 3

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Salt Fog Test		Testing discontinued due to failure of specimens 1, 2 and 3			
Cycle Test					
Burst Test					

SECTION I

INTRODUCTION

1.1 SCOPE

This report presents the results of tests that were performed to determine if Solenoid Valve 10425701-2 meets the operational and environmental requirements of the John F. Kennedy Space Center Launch Complexes 34 and 37B. A summary of the test results is presented on pages ix and x.

1.2 ITEM DESCRIPTION

Solenoid Valve 10425701-2 is manufactured by Flodyne Controls, Inc., as part number 3A37S. The valve is normally open, solenoid-operated to closed position, and has a 0.189 inch-diameter orifice. The valve ports are 3/8 inch nominal. The valve body is 316 stainless steel. The valve is rated for service with air, nitrogen, or helium at pressures ranging from zero to 3000 psig. The valve operates on 18 to 30 vdc and is used in the pneumatic distribution systems of complexes 34 and 37B.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Solenoid Valve 10425701-2.

- a. 10425701-2 component specification
- b. KSC-STD-164(D), Environmental Test Methods
- c. Test Plans CCSD-FO-1129-1F and 1130-1F
- d. Test Procedure TP-RE-CCSD-FO-1129-2F and 1130-2F

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

The solenoid valve shall be visually and dimensionally checked for conformance with NASA Specification 10425701-2 and the applicable vendor drawings to the extent possible without disassembling the specimen. The specimen shall also be inspected for poor workmanship and manufacturing defects.

2.2 TEST PROCEDURE

The specimen was checked for conformance with NASA specification 10425701-2, applicable vendor drawings, and for defective threads and poor workmanship.

2.3 TEST RESULTS

The specimen complied with drawing 10425701-2. No evidence of poor workmanship or other manufacturing defects was observed.

2.4 TEST DATA

Receiving inspection test data are shown in tables 2-1 and 2-2.

Table 2-1. Receiving Inspection Test Data

Description	Specimen 1	Specimen 2	Specimen 3
Valve Material	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Valve Ports	3/8 in.	3/8 in.	3/8 in.
Valve Weight	3-1/10 lb	3-1/10 lb	3-1/10 lb
Overall Length	6.5 in.	6.5 in.	6.5 in.
Overall Width	2.8 in.	2.8 in.	2.8 in.
Coil Housing Diameter	1.8 in.	1.8 in.	1.8 in.
Port Housing Length	2.0 in.	2.0 in.	2.0 in.

Table 2-2. Receiving Inspection Test Equipment List

Item No.	Item	Manufacturer	Model Part No.	Serial No.	Cal Date
1	Steel Scale	Brown & Sharpe	300	NASA 101-1013	7-23-64

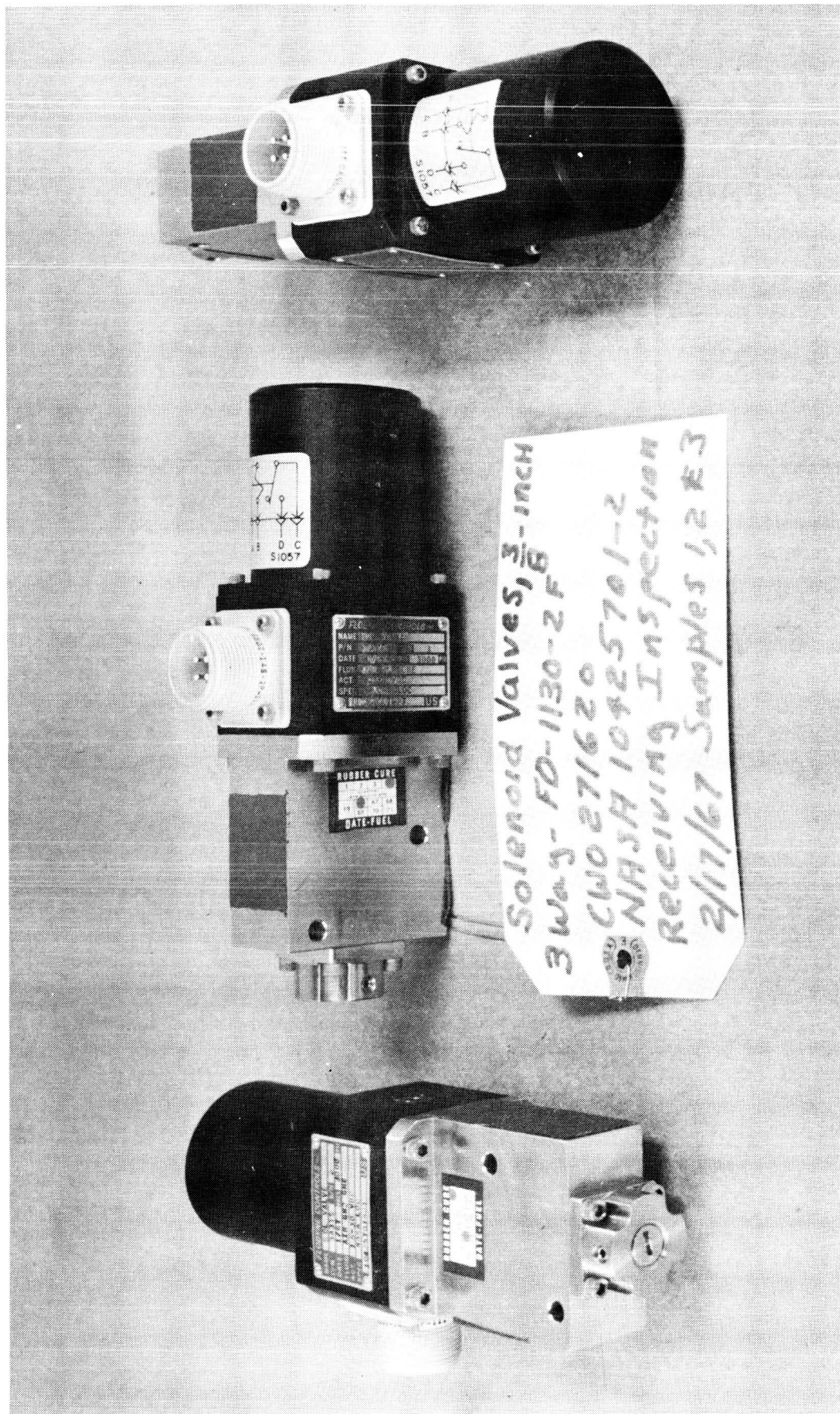


Figure 2-1. Solenoid Valve 10425701-2 Receiving Inspection

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

- 3.1.1 The test specimen shall be subjected to a proof pressure of 4500 psig using GN₂ as the test medium.
- 3.1.2 All ports shall be simultaneously pressurized for 5 minutes.
- 3.1.3 The test specimen shall be inspected for leakage and distortion.

3.2 TEST PROCEDURE

- 3.2.1 The test setup was assembled as shown in figure 3-1 and figure 3-2 using the equipment listed in table 3-1.
- 3.2.2 Hand valve 3 was closed and regulator 5 was adjusted for zero outlet pressure.
- 3.2.3 Hand valve 3 was opened. Gage 4 indicated 5000 psig.
- 3.2.4 Regulator 5 was adjusted to supply 4500 psig to the inlet port and both outlet ports of the specimen as indicated on gage 6. This pressure was retained for 5 minutes.
- 3.2.5 The specimen was checked for leakage by observing pressure gage 6 for an indication of a pressure drop. The inspection revealed no leakage or distortion.
- 3.2.6 All data were recorded.
- 3.2.7 Regulator 5 outlet pressure was reduced to zero as indicated on gage 6.

3.3 TEST RESULTS

Test specimens 1, 2 and 3 did not leak or show signs of distortion when the inlet port and both outlet ports were simultaneously pressurized to 4500 psig.

3.4 TEST DATA

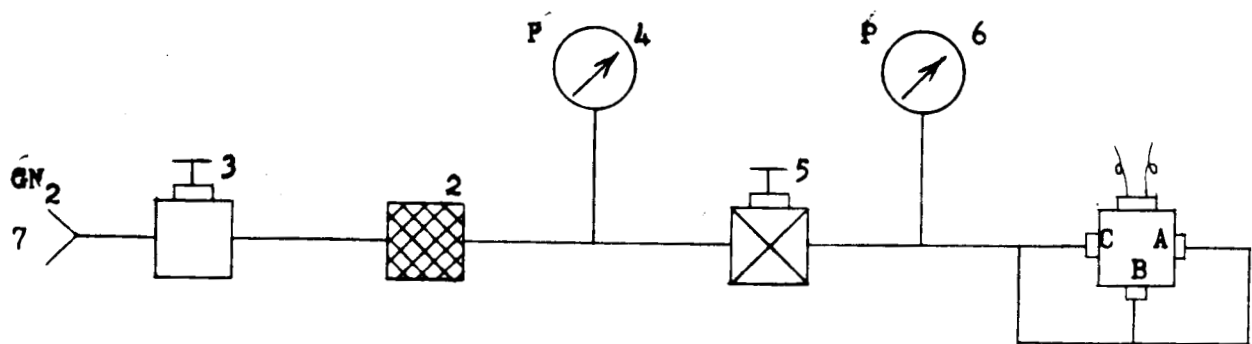
Test data are presented in table 3-2.

Table 3-1. Proof Pressure Test Equipment List

Item No.	Item	Manufacturer	Model/Part No.	Serial No.	Remarks
1	Test Specimen	Flodyne Controls, Inc. (FO-1130)	3A37S	1,2,3	Solenoid Valve 3/8-inch, 3-way
2	Filter	Microporous	4513F-2DM	NA	2-micron
3	Hand Valve	Combination Valve Pump Company	NA	NA	1-1/2-inch
4	Pressure Gage	Ashcroft	1850	NASA 200595-N	0-to 10,000 psig +1/2% FS Cal date 1/20/67
5	Regulator	Tescom	26-1022-30	1531	10,000-psig inlet 0-to 6000-psig outlet
6	Pressure Gage	Ashcroft	1850	NASA 200595-M	0-to 5000-psig +1/2% FS Cal date 1/20/67
7	GN ₂ Pressure Source	CCSD	NA	NA	5000-psig

Table 3-2. Leakage with Inlet and Outlet Ports
Simultaneously Pressurized

	Specimen 1	Specimen 2	Specimen 3
Pressure psig GN ₂	4500	4500	4500
Leakage	None	None	None



Note: All lines 1/4-inch.
Refer to table 3-1 for item identification.

Figure 3-1. Proof Pressure Test Schematic

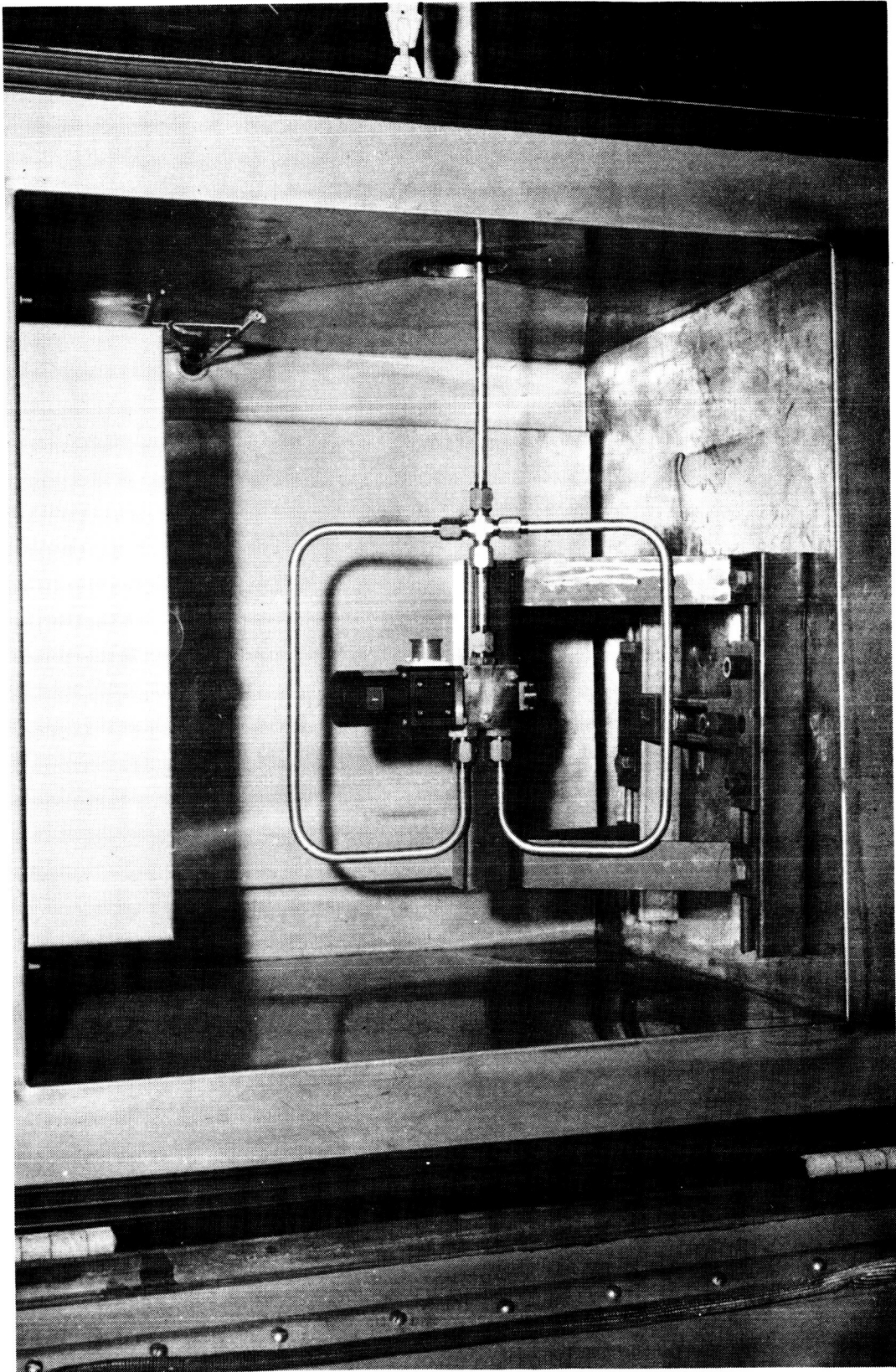


Figure 3-2. Proof Pressure Test Setup

SECTION IV
FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

- 4.1.1 A functional test shall be performed on the test specimen.
- 4.1.2 Insulation resistance and dielectric strength shall be determined between all nonconnected terminals and between each terminal and the case. The minimum resistance shall be 20 megohms and the maximum leakage current shall be 2 milliamperes.
- 4.1.3 The valve shall be cycled from the closed to the open position ten times while inlet port C is pressurized to 750 psig and ten times while outlet port A is pressurized to 750 psig. The pull-in voltage, drop-out voltage, coil current leakage at the closed port, poppet position, and response time shall be determined. Maximum leakage allowed through the closed port shall be 5 scim. The maximum allowable response time from fully closed to fully open is 65 milliseconds at 3000 psi and 28 vdc.
- 4.1.4 Step 4.1.3 shall be repeated using pressures of 1500 psig and 3000 psig.

4.2 TEST PROCEDURE

- 4.2.1 The functional test setup was assembled as shown in figures 4-1 and 4-2 using the equipment listed in table 4-1.
- 4.2.2 Megohmmeter 6 and dielectric strength tester 18 were used to measure the insulation resistance and leakage current between all nonconnected terminals and between each terminal and the case. The applied voltage was 500 vdc for a period of 60 seconds.
- 4.2.3 All hand valves were closed and regulator 5 was adjusted for zero outlet pressure.
- 4.2.4 Flex hose 20 was connected to port C, flex hose 21 to port B, and flex hose 22 to port A.
- 4.2.5 Hand valve 3 was opened allowing a 3200-psig supply pressure as indicated on gage 4.
- 4.2.6 Hand valve 12 was opened.
- 4.2.7 Regulator 5 was adjusted to provide the specimen inlet pressure to 750 psig, as indicated on gage 9.
- 4.2.8 Water tank 15 and graduated cylinder 17 were used to determine any specimen leakage.

- 4.2.9 Hand valve 12 was closed, hand valve 13 was opened and switch 23 was closed.
- 4.2.10 The voltage of power supply 8 was slowly increased until the specimen was actuated. The pull-in voltage indicated by voltmeter 16 was read at the moment of actuation.
- 4.2.11 The voltage was increased to 24 vdc and the coil current indicated by ammeter 7 was recorded.
- 4.2.12 Hand valve 13 was closed and hand valve 12 was opened. Specimen leakage was determined as indicated by water tank 15 and graduated cylinder 17.
- 4.2.13 Hand valve 12 was closed and hand valve 13 was opened.
- 4.2.14 The voltage of power supply 8 was slowly decreased until the specimen deactuated. The drop-out voltage was read as indicated by voltmeter 16 when the specimen deactuated.
- 4.2.15 The response time was monitored using oscillograph 19.
- 4.2.16 The procedures were repeated as described in 4.2.10 through 4.2.15 for a total of 10 cycles.
- 4.2.17 All hand valves were closed, regulator 5 was adjusted to zero psig, and flex hoses 20, 21, and 22 were disconnected.
- 4.2.18 Flex hose 20 was connected to port A, flex hose 21 to port C, and port B was capped.
- 4.2.19 The procedures described in 4.2.5 through 4.2.11 were repeated.
- 4.2.20 The procedures described in 4.2.14 and 4.2.15 were repeated.
- 4.2.21 The procedures described in 4.2.19 and 4.2.20 were repeated for a total of 10 cycles.
- 4.2.22 T The procedures described in 4.2.3 through 4.2.16 were performed by applying 1500 psig to port C.
- 4.2.23 The procedures described in 4.2.19 through 4.2.21 were performed by applying 1500 psig to port A.
- 4.2.24 The procedures described in 4.2.3 through 4.2.11 were performed by applying 3000 psig to port C. After step 4.2.11, the response time of the valve was measured at 3000 psig and 28 vdc. The procedures described in 4.2.16 were performed by applying 3000 psig to port C.
- 4.2.25 The procedures described in 4.2.19 through 4.2.21 were performed by applying 3000 psig to port A.
- 4.2.26 All test data were recorded.

4.3 TEST RESULTS

4.3.1 Specimens as Received

Test specimens 1, 2 and 3 malfunctioned during the initial functional test. Specimens 1 and 2 leaked in excess of the 5 scim specification and specimen 3 indicated a short from pin "C" of the receptacle to the housing. The specimens were returned to the vendor for reworking.

4.3.2 Specimens after rework by vendor.

4.3.2.1 Test specimen 1 satisfactorily completed the functional test after being returned by the vendor. After a 72 hour operating delay, another functional test was performed. The results were again unsatisfactory as excessive leakage occurred.

4.3.2.2 Reworked specimen 2 needed continuous adjustment to eliminate excessive leakage during the second functional test.

4.3.2.3 The indicating switch wire "C" was still shorted to the housing on specimen 3, however, this did not effect the operation of the valve.

4.4 TEST DATA

Test data are presented in tables 4-2 through 4-22.

Table 4-1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Flodyne Control, Inc. (FO-1130	3A37S	1, 2, 3	Solenoid Valve, 3/8-inch, 3-way
2	Filter	Bendix	2-S-13460 16-B-0	58	2-micron
3	Hand Valve	Combination Valve and Pump	NA	NA	1-1/2-inch
4	Pressure Gage	Duragauge	1850	NASA 200616-L	0-to 5000-psig +1/2% FS Cal date 1/24/67
5	Regulator	Tescom	26-1003	321	3200-psig inlet 0-to 3000-psig outlet
6	Megohmmeter	General Radio	Type 1862 C	NASA 018416	500-vdc
7	Ammeter	Sorensen	NA	NA	0-to 5 amp DC
8	Power Supply	Sorensen	NA	NASA 015447	Variable, 0-to 30-vdc
9	Pressure Gage	Duragauge	1850	NASA 200616-F	0-to 5000-psig +0.25% FS Cal date 1/24/67
10	Temperature Chamber	Conrad	NA	NASA 200494-1	-5 to +165°F (required for temperature test only)
11	GN ₂ Source	Air Products	NA	NA	3200-psig
12	Hand Valve	Robbins	SSKG 250- 4T		1/4-inch
13	Hand Valve	Robbins	SSKG 250- 4T		1/4-inch
14	Hand Valve	Robbins	SSKG 250- 4T		1/4-inch

Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
15	Water Tank	CCSD	NA	NA	
16	Voltmeter	Sorensen	NA	NA	0-to 30-vdc
17	Graduated Cylinder	ASTM	NA	NA	10cc
18	Dielectric Strength Tester	Wiley Electronics	5-F	NASA 015241	Cal date 1/10/67
19	Oscillograph	CEC	5-124	NASA 012588	Cal date 1/9/67
20	Flex Hose	Local Manufacturer	NA	NA	1/4-inch
21	Flex Hose	Local Manufacturer	NA	NA	1/4-inch
22	Flex Hose	Local Manufacturer	NA	NA	1/4-inch
23	Switch	Cutler-Hammer	NA	NA	SPST
24	Thermocouple	Honeywell	NA	NA	Copper construction
25	Temperature Readout Device	Honeywell	152C15- PH-239- III-91	R3646196 001	-25 to 525°F

Table 4-2. Initial Insulation and Resistance Functional Test Data (Specimen 1)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Ground	B to Ground	C to Ground	D to Ground
Megohms	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5
Milliamperes	2.08×10^{-2}	2.08×10^{-2}	2.08×10^{-2}	2.08×10^{-2}	2.08×10^{-2}	2.08×10^{-2}	2.08×10^{-2}	2.08×10^{-2}	2.08×10^{-2}

Table 4-3. Initial Functional Test Data (Specimen 1)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	12.75	1.10	1.0	50	80	0	0
	2	14.00	1.10	1.0	55	80	0	0
	3	13.50	1.10	1.0	60	80	0	0
	4	13.75	1.10	1.0	60	80	0	0
	5	13.75	1.10	1.0	60	80	0	0
	6	14.00	1.05	1.0	60	80	0	0
	7	14.00	1.025	1.0	60	80	0	0
	8	14.25	1.025	1.0	60	80	0	0
	9	14.25	1.025	1.0	60	80	0	0
	10	14.25	1.025	1.0	60	80	0	0
Pressurizing Port A 750 psig - GN ₂	1	13.50	1.125	0.1	55	85	0	
	2	13.00	1.15	0.1	55	85	0	
	3	13.00	1.15	0.1	55	90	0	
	4	13.00	1.15	0.1	55	90	0	
	5	13.00	1.15	0.1	55	90	0	
	6	13.00	1.15	0.0	55	90	0	
	7	13.00	1.15	0.0	55	90	0	
	8	12.75	1.15	0.0	55	90	0	
	9	12.75	1.15	0.0	55	90	0	
	10	12.75	1.15	0.0	55	90	0	
Pressurizing Port C 1500 psig - GN ₂	1	13.00	1.13	0.75	67	130	0	0.07
	2	14.25	1.15	0.75	68	130		0.21
	3	14.00	1.16	0.75	67	130		0.17
	4	14.00	1.18	0.75	66	130		0.20
	5	14.00	1.13	0.75	67	130		0.17
	6	14.00	1.16	0.50	66	130		0.17
	7	14.00	1.125	0.50	67	130		0.17
	8	14.00	1.125	0.75	67	130		0.17
	9	14.00	1.15	0.50	67	130		0.21
	10	14.00	1.13	0.75	67	130		0.24

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-3. Initial Functional Test Data, Specimen 1 (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - GN ₂	1	13.90	1.13	0.0	56	120	0	
	2	13.00	1.13	0.0	57	125	0	
	3	13.00	1.13	0.0	58	130	0	
	4	13.00	1.12	0.0	58	130	0	
	5	13.00	1.13	0.0	57	130	0	
	6	13.00	1.13	0.0	57	130	0	
	7	13.00	1.13	0.0	57	130	0	
	8	13.00	1.14	0.0	55	130	0	
	9	13.00	1.13	0.0	55	130	0	
	10	13.00	1.13	0.0	55	130	0	
Pressurizing Port C 3000 psig - GN ₂	1	14.5	1.05	0.5			0	Leaked in excess of 1400 scim and was sent back to the vendors for reworking
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-4. Functional Insulation and Resistance Test Data After Vendor Rework (Specimen 1)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Ground	B to Ground	C to Ground	D to Ground
Megohms	2.7×10^4	2.7×10^4	3.3×10^4	1.5×10^5	2.8×10^4	3.3×10^4	3.3×10^4	2.8×10^4	3.0×10^4
Milliamperes	1.85×10^{-2}	1.85×10^{-2}	1.5×10^{-2}	3.5×10^{-3}	1.7×10^{-2}	1.5×10^{-2}	1.5×10^{-2}	1.7×10^{-2}	2.0×10^{-2}

Table 4-5. Functional Test Data After Vendor Rework (Specimen 1)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	12.0	1.10	6.0	56	45	0	0
	2	13.0	1.11	6.15	56	45	0	0
	3	12.2	1.10	6.5	56	45	0	0
	4	12.0	1.40	6.2	56	45	0	0
	5	12.2	1.15	6.2	56	45	0	0
	6	12.1	1.10	6.2	56	45	0	0
	7	12.2	1.10	6.2	56	45	0	0
	8	12.2	1.10	6.2	56	45	0	0
	9	12.4	1.10	6.2	56	45	0	0
	10	12.4	1.10	6.2	56	45	0	0
Pressurizing Port A 750 psig - GN ₂	1	13.5	1.06	5.5	50	43	0	
	2	13.3	1.06	5.5	50	45	0	
	3	13.3	1.06	5.6	50	45	0	
	4	13.3	1.06	5.6	50	45	0	
	5	13.3	1.06	5.6	50	45	0	
	6	13.3	1.06	5.6	50	45	0	
	7	13.3	1.06	5.6	50	45	0	
	8	13.3	1.06	5.6	50	45	0	
	9	13.3	1.06	5.6	50	45	0	
	10	13.3	1.06	5.6	50	45	0	
Pressurizing Port C 1500 psig - GN ₂	1	12.1	1.15	5.5	58	55	0	0
	2	12.0	1.11	5.5	Indicating switch failed to open, then operated properly at the end of 10 cycles. Testing was continued.		0	0
	3	12.2	1.10	5.8			0	0
	4	12.2	1.00	5.8			0	0
	5	12.2	1.12	5.5			0	0
	6	12.2	1.10	5.6			0	0
	7	12.2	1.10	5.6			0	0
	8	12.2	1.05	5.6			0	0
	9	12.5	1.05	5.7			0	0
	10	12.5	1.05	5.7			0	0

Allowable response time to 60 psi at 2000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-5. Functional Test Data After Vendor Reworked, Specimen 1 (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - CN ₂	1	14.0	1.07	5.0	55	54	0	
	2	15.9	1.07	5.0	55	54	0	
	3	15.9	1.07	5.0	54	55	0	
	4	13.8	1.08	5.0	54	55	0	
	5	13.8	1.07	5.0	55	54	0	
	6	13.8	1.07	5.0	55	55	0	
	7	13.8	1.07	5.0	54	55	0	
	8	13.8	1.07	5.0	55	55	0	
	9	13.8	1.07	5.1	55	55	0	
	10	13.8	1.06	5.1	54	54	0	
Pressurizing Port C 3000 psig - CN ₂	1	11.0	1.1	5.0	60	70	0	0
	2	10.1	1.1	5.0	65	68	0	0
	3	10.1	1.08	5.0	63	67	0	0
	4	9.9	1.07	5.1	65	68	0	0
	5	9.9	1.05	5.1	62	72	0	0
	6	9.9	1.05	5.1	63	68	0	0
	7	9.9	1.05	5.1	64	70	0	0
	8	9.9	1.05	5.1	65	68	0	0
	9	9.9	1.05	5.1	65	70	0	0
	10	9.9	1.05	5.1	65	68	0	0
Pressurizing Port A 3000 psig - CN ₂	1	14.1	1.1	4.8	60	70	0	
	2	13.8	1.08	4.8	65	68	0	
	3	13.5	1.07	4.8	63	67	0	
	4	13.2	1.07	4.8	65	72	0	
	5	13.2	1.07	4.8	62	70	0	
	6	13.1	1.07	4.9	63	68	0	
	7	13.0	1.07	4.9	64	70	0	
	8	13.0	1.07	5.0	65	68	0	
	9	13.0	1.08	5.0	65	70	0	
	10	13.0	1.08	5.0	65	68	0	

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-6. Functional Insulation and Resistance Test Data After 72 Hour Delay
Prior to Low Temperature Test (Specimen 1)

Pin No.	A to C	A to D	C to D	B to C	B to D	A to Ground	B to Ground	C to Ground	D to Ground
Megohms	1.2×10^4	3.5×10^6	1.1×10^4	2.7×10^4	2.5×10^6	2.5×10^6	2.5×10^4	2.5×10^6	7.5×10^3
Milliamperes	5.0×10^{-2}	1.4×10^{-4}	4.4×10^{-2}	1.8×10^{-2}	2.0×10^{-4}	2.0×10^{-4}	2.0×10^{-2}	2.0×10^{-4}	6.6×10^{-2}

Table 4-7. Functional Test Data After 72-Hour Delay Prior To Low Temperature Test (Specimen 1)

Port	Run Nc.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - CN ₂	1	13.3	1.15	1.3	60	72	0	1.5
	2	13.2	1.12	1.0	62	74	0	3.5
	3	13.2	1.10	0.9	63	70	0	5.0
	4	10.1	1.10	0.8	62	73	0	5.25
	5	9.8	1.05	0.8	64	74	0	4.0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - CN ₂	1						410	
	2						425	
	3						Testing was	
	4						halted.	
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-8. Functional Test Data After New Spring Installation (Specimen 1)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - CN_2	1	19.9	1.00	4.5	109	18	0	0
	2	20.8	1.00	4.5	108	18	0	0
	3	20.8	1.00	4.5	107	19	0	0
	4	20.8	1.00	4.5	110	21	0	0
	5	20.9	0.98	4.4	110	19	0	0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - CN_2	1	20.5	1.1	3.6	96	23	0	
	2	21.4	1.1	3.2	96	24	0	
	3	21.2	1.07	3.3	96	24	0	
	4	21.2	1.1	3.5	96	23	0	
	5	21.4	1.1	3.8	96	24	0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - CN_2	1	23.7	0.9	2.5	120	30	0.7	0.75
	2	18.8	1.05	4.0	120	30	2.05	0.3
	3	18.8	1.05	4.0	119	30	2.4	0.35
	4	18.5	1.08	3.4	121	30	3.25	0.35
	5	18.5	1.1	3.4	119	30	4.8	0.33
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-8. Functional Test Data After New Spring Installation, Specimen 1 (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - CN ₂	1	23.4	1.09	2.5	118	36	0	
	2	23.8	1.09	4.0	119	36	0	
	3	23.8	1.09	4.0	118	36	0	
	4	23.8	1.09	3.4	118	36	0	
	5	23.5	1.1	3.4	118	36	0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 3000 psig - CN ₂	1	20.0	1.0	3.5	153	40	10.0	2.5
	2	19.5	0.95	3.8	154	40	8.0	11.25
	3	19.0	0.95	3.9	153	40	7.5	14.55
	4	19.0	0.95	3.9	153	40	7.0	71.50
	5	19.0	0.95	3.9	Excessive time to open		5.75	1260.00
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 3000 psig - CN ₂	1							Test dis-
	2							continued
	3							permanently
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-9. Initial Insulation and Resistance Functional Test Data (Specimen 2)

Pin No.	C to D	D to B	C to B	A to B	A to D	A to Ground	B to Ground	C to Ground	D to Ground
Megohms	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5
Milliamperes	3.5×10^{-3}	3.5×10^{-3}	3.5×10^{-3}	3.5×10^{-3}	3.5×10^{-3}	3.5×10^{-3}	3.5×10^{-3}	3.5×10^{-3}	3.5×10^{-3}

Table 4-10. Initial Functional Test Data (Specimen 2)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port	1	13.0	—	—	—	—	0	Leaked in excess of 1400 scim. Specimen sent back to the vendor for reworking.
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-11. Functional Insulation and Resistance Test Data After Vendor Rework (Specimen 2)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Housing	B to Housing	C to Housing	D to Housing
Megohms	1.3×10^4	2.0×10^6	2.6×10^4	4.5×10^6	1.6×10^4	1.7×10^4	1.7×10^4	1.7×10^4	1.6×10^4
Milliamperes	3.8×10^{-2}	2.5×10^{-4}	1.9×10^{-2}	1.1×10^{-4}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}

Table 4-12. Functional Test Data After Vendor Rework (Specimen 2)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	14.0	1.11	5.0	56	40	0	0
	2	13.8	1.10	5.0	57	42	0	0
	3	13.9	1.10	5.0	60	41	0	0
	4	14.1	1.10	5.1	60	42	0	0
	5	14.4	1.10	5.1	58	41	0	0
	6	14.7	1.08	5.2	57	43	0	0
	7	14.9	1.05	5.2	56	45	0	0
	8	15.0	1.05	5.2	57	43	0	0
	9	15.1	1.05	5.2	58	42	0	0
	10	15.1	1.03	5.2	58	41	0	0
Pressurizing Port A 750 psig - GN ₂	1	15.0	1.06	4.1	57	43	0	
	2	14.8	1.07	4.2	58	45	0	
	3	14.5	1.07	4.3	57	43	0	
	4	14.5	1.07	4.3	57	42	0	
	5	14.5	1.06	4.3	58	43	0	
	6	14.5	1.06	4.3	56	44	0	
	7	14.5	1.06	4.3	58	43	0	
	8	14.5	1.06	4.3	59	42	0	
	9	14.5	1.06	4.3	58	43	0	
	10	14.5	1.05	4.3	58	42	0	
Pressurizing Port C 1500 psig - GN ₂	1	14.1	1.10	4.1	65	43	0	0
	2	14.3	1.10	4.2	64	43	0	0
	3	14.4	1.08	4.3	63	45	0	0
	4	14.7	1.07	4.3	63	43	0	0
	5	14.8	1.05	4.3	64	44	0	0
	6	14.9	1.05	4.3	64	45	0	0
	7	14.8	1.05	4.3	63	43	0	0
	8	14.8	1.05	4.3	64	44	0	0
	9	15.0	1.05	4.3	63	44	0	0
	10	15.0	1.01	4.3	65	43	0	0

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-12. Functional Test Data After Vendor Rework, Specimen 2 (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - GN ₂	1	14.8	1.07	4.8	65	56	0	
	2	13.8	1.07	4.8	65	55	0	
	3	13.8	1.07	4.8	65	54	0	
	4	13.8	1.07	4.8	65	55	0	
	5	13.8	1.07	4.9	65	55	0	
	6	13.8	1.07	4.8	65	56	0	
	7	13.5	1.07	4.8	65	55	0	
	8	13.5	1.06	4.8	65	56	0	
	9	13.4	1.06	4.9	65	56	0	
	10	13.4	1.06	4.9	65	56	0	
Pressurizing Port C 3000 psig - GN ₂	1	13.2	1.18	2.7	100	80	0	0
	2	12.8	1.15	2.8	96	80	0	0
	3	12.5	1.10	2.9	95	80	0	0
	4	12.5	1.10	3.0	93	80	0	0
	5	12.6	1.09	3.1	90	80	0	0
	6	12.8	1.07	3.1	88	80	0	0
	7	12.8	1.05	3.2	84	80	0	0
	8	13.0	1.05	3.2	86	80	0	0
	9	13.3	1.02	3.2	83	80	0	0
	10	13.3	1.05	3.2	81	80	0	0
Pressurizing Port A 3000 psig - GN ₂	1	14.5	1.08	4.5	80		0	
	2	13.5	1.08	4.5	83		0	
	3	13.5	1.08	4.5	84		0	
	4	13.5	1.08	4.5	85		0	
	5	13.5	1.07	4.5	84		0	
	6	13.5	1.08	4.5	80		0	
	7	13.5	1.07	4.5	84		0	
	8	13.3	1.08	4.5	Excessive time to open		0	
	9	13.3	1.08	4.4			0	
	10	13.5	1.08	4.4			0	

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-13. Functional Insulation and Resistance Test Data After 72 Hour Delay Prior to Low Temperature Test (Specimen 2)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Housing	B to Housing	C to Housing	D to Housing
Megohms	1.3×10^4	2.1×10^6	2.6×10^4	4.3×10^6	1.6×10^4	1.7×10^4	1.7×10^4	1.7×10^4	1.6×10^4
Milliamperes	3.8×10^{-2}	2.5×10^{-4}	1.9×10^{-2}	1.1×10^{-4}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}

Table 4-14. Functional Test Data After 72 Hour Delay Prior To Low Temperature Test (Specimen 2)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	15.5	1.00	5.6	64	81	0	0
	2	15.2	1.00	5.4	65	80	0	0
	3	15.0	1.00	5.5	64	82		13.0
	4	15.0	1.00	5.4	65	80		20.0
	5	15.0	1.00	5.8	66	80		21.0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - GN ₂	1	13.5	1.08	5.0	66	75	0	
	2	15.2	1.07	5.0	65	74	0	
	3	15.0	1.07	4.9	64	73	0	
	4	15.0	1.07	4.9	65	74	0	
	5	15.0	1.07	4.8	63	73	0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - GN ₂	1	14.8	1.03	4.8	70	78	0	13.0
	2	14.7	1.00	4.8	65	82	0	8.5
	3	14.7	1.00	4.7	63	81	0	8.0
	4	14.0	1.00	4.8	64	82	50.0	6.5
	5	14.5	1.00	4.8	65	82	167.5	6.5
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds
Allowable leakage: 5 scim

Table 4-14. Functional Test Data After 72 Hour Delay Prior To Low Temperature Test, Specimen 2 (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - GN ₂	1						Excessive leakage	
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 3000 psig - GN ₂	1	12.5	1.02	3.6	64	82	300	8.0
	2						Test Halted	
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 3000 psig - GN ₂	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-15. Functional Insulation and Resistance Test Data
After Valve Adjustment (Specimen 2)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Housing	B to Housing	C to Housing	D to Housing
Megohms	1.2×10^4	2.0×10^6	2.6×10^4	4.0×10^4	1.4×10^4	1.6×10^4	1.6×10^4	1.6×10^4	1.6×10^4
Milliamperes	4.2×10^{-2}	2.5×10^{-4}	1.9×10^{-2}	1.2×10^{-2}	3.6×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	3.4×10^{-2}

Table 4-16. Functional Test Data After Requested Valve Adjustment (Specimen 2)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	15.0	1.10	5.8	74	92	0	5.5
	2	17.2	1.08	6.3	72	92		8.0
	3	16.9	1.00	6.5	73	91		6.5
	4	16.6	1.00	6.2	74	92		6.7
	5	16.5	1.00	6.5	72	92		6.6
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - GN ₂	1	10.2	1.06	3.5	72	82	0	
	2	10.2	1.06	3.5	72	82	0	
	3	10.0	1.06	3.5	73	82	3.5	
	4	10.0	1.06	3.5	74	83	3.5	
	5	10.0	1.06	3.5	74	82	6.0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - GN ₂	1	17.5	1.05	6.8	72	94	0	12.5
	2	17.5	1.00	7.0	72	93	0	12.5
	3	17.2	1.00	7.0	73	92	0	11.5
	4	17.8	1.00	7.0	74	90	0	17.4
	5	17.3	1.00	7.0	74	90	0	16.0
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-16. Functional Test Data After Requested Valve Adjustment, Specimen 2 (Continued)

Port	Run No.	Bull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - GN ₂	1	12.0	1.03	3.6	45	88	0	
	2	11.4	1.03	3.5	45	88	0	
	3	11.0	1.03	3.6	45	88	0	
	4	11.0	1.03	3.5	45	88	0	
	5	11.0	1.03	3.5	45	88	0	
Pressurizing Port C 3000 psig - GN ₂	1	14.8	1.08	6.4	56	93	0	8.0
	2	13.8	1.08	6.2	56	92	0	8.0
	3	12.4	1.05	6.0	55	91	0	3.5
	4	13.0	1.10	5.8	57	90	0	3.2
	5	13.2	1.10	6.2	57	91	0	3.5
Pressurizing Port A 3000 psig - GN ₂	1	13.0	1.06	4.0	58	108	0	
	2	13.0	1.07	3.5	58	108	0	
	3	12.5	1.07	3.5	58	108	0	
	4	12.5	1.07	3.5	58	108	0	
	5	12.5	1.07	3.5	58	108	0	

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-17. Initial Insulation and Resistance Functional Test Data (Specimen 3)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Ground	B to Ground	C to Ground	D to Ground
Megohms	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5	2.4×10^5
Milliamperes	2.1×10^{-3}	2.1×10^{-3}	2.1×10^{-3}	2.1×10^{-3}	2.1×10^{-3}	2.1×10^{-3}	2.1×10^{-3}	2.1×10^{-3}	2.1×10^{-3}

Table 4-18. Initial Functional Test Data (Specimen 3)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - CN_2	1	13.0	1.05	0.2	74	148	0	0
	2	12.75	1.05	0.2	65	148		0
	3	12.75	1.1	0.2	76	154		0
	4	12.75	1.1	0.2	77	144		0
	5	13.0	1.1	0.2	66	152		0
	6	12.75	1.1	0.3	70	155		0
	7	13.00	1.1	0.2	87	155		0
	8	12.75	1.1	0.2	79	155		0
	9	12.75	1.1	0.1	81	150		0
	10	12.75	1.1	0.1	80	169		0
Pressurizing Port A 750 psig - CN_2	1	13.75	1.1	0.0	60	95	0	
	2	13.75	1.1	0.0	60	95	0	
	3	13.00	1.1	0.0	60	100	0	
	4	12.75	1.1	0.0	60	100	0	
	5	12.75	1.1	0.0	60	95	0	
	6	12.75	1.1	0.0	60	95	0	
	7	12.50	1.1	0.0	60	100	0	
	8	12.75	1.1	0.0	60	100	0	
	9	12.25	1.1	0.0	60	100	0	
	10	12.25	1.1	0.0	60	95	0	
Pressurizing Port C 1500 psig - CN_2	1	13.0	1.11	0.0	60	110	0	0
	2	12.25	1.2	0.0	Switch failed to open. The specimen was sent back to the vendors for reworking.			0
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-19. Functional Insulation and Resistance Test Data After Vendor Rework (Specimen 3)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Housing	B to Housing	C to Housing	D to Housing
Megohms	1.4×10^4	1.4×10^4	2.8×10^4	6.0×10^4	2.3×10^4	6.0×10^5	8.0×10^5	Shorted	3.0×10^4
Milliamperes	3.5×10^{-2}	3.5×10^{-2}	1.7×10^{-2}	8.3×10^{-3}	6.0×10^{-2}	8.3×10^{-4}	6.2×10^{-4}	-	2.0×10^{-2}

Table 4-20. Functional Test Data After Vendor Rework (Specimen 3)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Uncenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - CN ₂	1	10.0	1.15	4.8	41	20	0	0
	2	10.0	1.15	4.2	42	20		0
	3	9.9	1.12	4.9	40	20		0
	4	9.9	1.1	4.8	41	20		0
	5	10.2	1.1	4.7	42	20		0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - CN ₂	1	10.5	1.1	3.5	40	35	0	
	2	10.5	1.1	3.5	41	35	0	
	3	10.5	1.1	3.5	40	35	0	
	4	10.5	1.1	3.5	41	36	0	
	5	10.5	1.1	3.5	40	34	0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - CN ₂	1	10.4	1.1	4.0	45	30	0	0
	2	10.3	1.1	4.0	45	30		0
	3	10.2	1.08	4.0	44	30		0
	4	10.1	1.08	3.9	43	30		0
	5	10.1	1.08	3.9	45	30		0
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-20. Functional Test Data After Vendor Rework, Specimen 3 (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - GN ₂	1	11.5	1.11	3.2	43	40	0	
	2	11.1	1.12	3.3	43	40	0	
	3	11.0	1.1	3.2	42	40	0	
	4	10.9	1.1	3.2	43	40	0	
	5	10.8	1.1	3.2	42	40	0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 3000 psig - GN ₂	1	10.0	1.09	3.2	48	48	0	0
	2	9.6	1.08	3.2	50	48	0	0
	3	9.2	1.05	3.2	51	48	0	0
	4	8.4	1.03	3.2	48	48	0	0
	5	8.7	1.05	3.2	49	48	0	0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 3000 psig - GN ₂	1	11.8	1.13	2.9	50	54	0	
	2	11.6	1.13	2.9	50	55	0	
	3	11.3	1.13	2.9	50	55	0	
	4	11.2	1.14	2.9	50	55	0	
	5	11.2	1.14	3.0	50	54	0	
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 4-21. Functional Insulation and Resistance Test Data After 72 Hour
Delay Prior to High Temperature Test (Specimen 3)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Housing	B to Housing	C to Housing	D to Housing
Megohms	1.35×10^4	1.15×10^4	1.4×10^4	3.0×10^4	7.5×10^5	5.0×10^5	5.0×10^5	Shorted	5.0×10^5
Milliamperes	3.7×10^{-2}	4.3×10^{-2}	3.9×10^{-2}	1.8×10^{-2}	6.7×10^{-4}	1.0×10^{-4}	1.0×10^{-4}	-	1.0×10^{-4}

Table 4-22. Functional Test Data After 72 Hour Delay Prior To High Temperature Test (Specimen 3)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - CN ₂	1	12.2	1.15	4.6	49	17	0	0
	2	12.2	1.08	4.6	49	17	0	0
	3	12.2	1.07	4.6	49	17	0	0
	4	12.2	1.06	4.0	49	17	0	0
	5	12.4	1.06	4.6	49	17	0	0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - CN ₂	1	13.0	1.0	4.4	48	25	0	
	2	13.0	1.1	4.7	48	24	0	
	3	12.6	1.1	4.5	47	25	0	
	4	12.6	1.1	4.6	57	25	0	
	5	12.6	1.1	4.6	48	25	0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - CN ₂	1	12.2	1.2	4.2	49	21	0	0
	2	12.4	1.08	4.2	49	22	0	0
	3	12.2	1.06	4.2	48	22	0	0
	4	12.0	1.05	4.2	48	21	0	0
	5	12.2	1.03	4.2	49	21	0	0
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

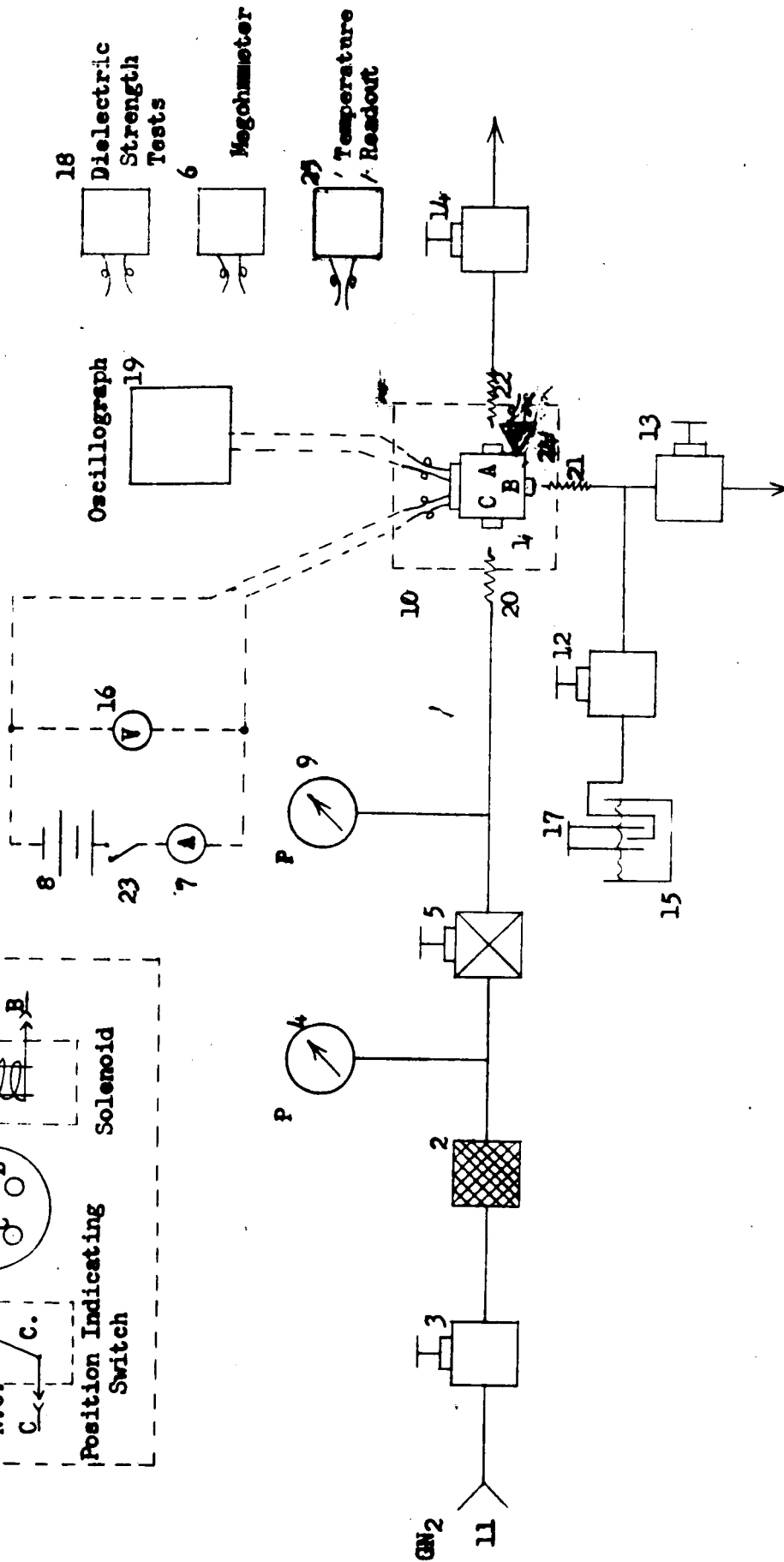
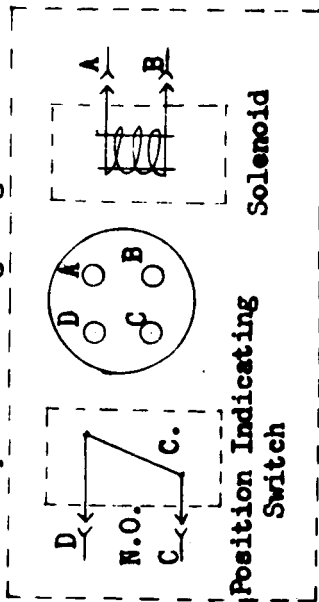
Table 4-22. Functional Test Data After 72 Hour Delay Prior To High Temperature Test, Specimen 3 (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port A 1500 psig - GN ₂	1	13.5	1.1	4.5	48	31	0	
	2	13.3	1.1	4.5	48	32	0	
	3	13.2	1.1	4.5	49	31	0	
	4	13.2	1.1	4.5	48	31	0	
	5	13.0	1.1	4.5	49	32	0	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 3000 psig - GN ₂	1	10.5	1.1	4.0	68	35	0	0
	2	10.5	1.11	4.0	68	34	0	0
	3	10.5	1.1	3.5	69	35	0	0
	4	10.5	1.08	3.5	68	34	0	0
	5	10.5	1.06	3.5	58	35	0	0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 3000 psig - GN ₂	1	13.0	1.1	4.2	60	45	0	
	2	13.5	1.11	4.0	60	45	0	
	3	13.2	1.10	4.5	60	46	0	
	4	13.2	1.1	4.5	61	46	0	
	5	13.2	1.1	4.5	60	45	0	
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Receptacle Wiring Diagram



Note: All lines 1/4-inch,
Refer to table 4-1 for item identification.

Figure 4-1. Functional Test Schematic

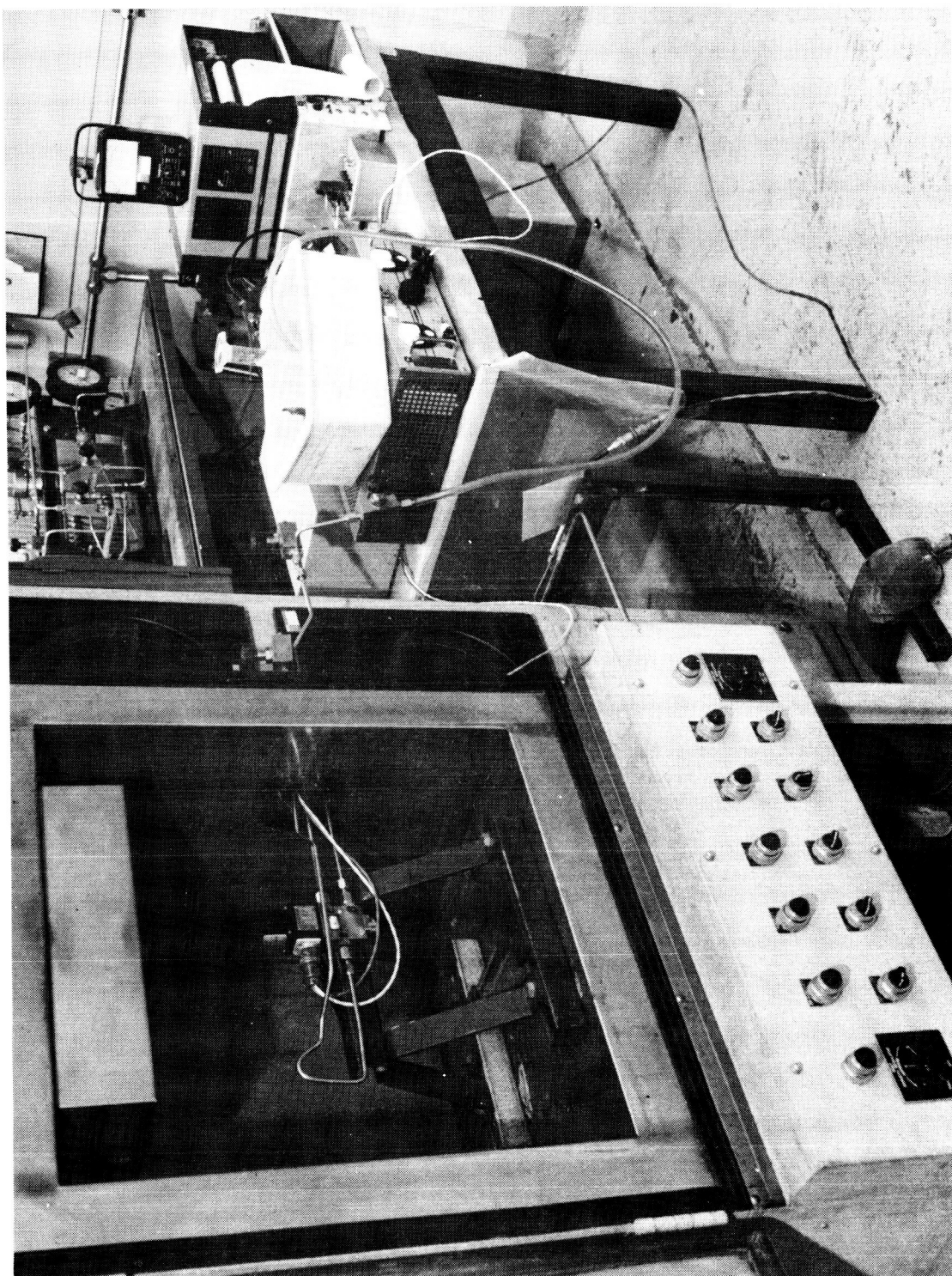


Figure 4-2. Functional Test Setup

SECTION V

LOW TEMPERATURE TEST

5.1 TEST REQUIREMENTS

- 5.1.1 A low temperature test will be performed on the test specimen to determine whether the environment causes degradation or deformation.
- 5.1.2 The rated low temperature is $0(+0, -4)^{\circ}\text{F}$. Maximum temperature change rate shall be 1°F per minute.
- 5.1.3 A functional test shall be performed during this test.

5.2 TEST PROCEDURE

- 5.2.1 The test specimen was placed in a low temperature chamber and the chamber was installed in the test setup as shown in figure 4-1 using the equipment listed in table 4-1.
- 5.2.2 A functional test was performed because 72 hours or more had elapsed since the previous functional test.
- 5.2.3 The chamber was controlled at $0(+0, -4)^{\circ}\text{F}$ and relative humidity between 60 and 90 percent was maintained. The temperature change rate was limited to 1°F per minute.
- 5.2.4 A functional test was performed when the temperature was stabilized at $0(+0, -4)^{\circ}\text{F}$. Temperature stabilization is defined as a maximum specimen temperature change rate of 4°F per hour as read on meter 25.
- 5.2.5 The chamber temperature was returned to ambient conditions after completion of the functional test.
- 5.2.6 The specimen was visually inspected and functionally tested within 1 hour following the return of the specimen to ambient conditions.
- 5.2.7 All test data were recorded.

5.3 TEST RESULTS

- 5.3.1 Test specimen 2 leaked in excess of 1470 scim when pressurized to 3000 psig through port C (unenergized). Testing was permanently discontinued.

5.4

TEST DATA

Low temperature test data are presented in tables 5-1 through 5-4.

Table 5-1. Functional Insulation and Resistance Test Data During Low Temperature Test (Specimen 2)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Housing	B to Housing	C to Housing	D to Housing
Megohms	1.2×10^4	2.0×10^4	2.4×10^4	3.9×10^4	1.5×10^6	1.6×10^4	1.6×10^4	1.6×10^4	1.6×10^4
Milliamperes	4.2×10^{-2}	2.5×10^{-2}	2.1×10^{-2}	1.3×10^{-2}	3.3×10^{-2}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}	3.1×10^{-2}

Table 5-2. Functional Test Data During Low Temperature Test (Specimen 2)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	12.0	1.12	3.4	100	550	12	4.0
	2	9.5	1.15	3.5	102	555	15.8	1.8
	3	9.5	1.15	3.7	Excessive time to open		Failed	
	4	9.7	1.10	4.0				
	5	9.8	1.10	4.1				
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - GN ₂	1	12.4	1.23	3.2			0	
	2	12.0	1.10	3.4			9.0	
	3	11.8	1.1	3.4			10.0	
	4						Failed	
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - GN ₂	1						12.0	
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 5-2. Functional Test Data During Low Temperature Test (Specimen 2) (Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 3000 psig - GN ₂	1						16.0 Test Halted	
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 5-3. Functional Test Data During a Requested Temperature of 20(+0,-4)°F Specimen 2

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	10.0	1.10	4.0	59	250	6.0	0
	2	10.0	1.10	4.0	59	250	7.25	0
	3	9.8	1.10	4.0	59	250	7.25	0
	4	9.5	1.10	4.1	59	250	8.25	0
	5	9.5	1.10	4.2	59	250	Failed	0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port A 750 psig - GN ₂	1	10.5	1.10	3.0	63	200	0	
	2	10.5	1.10	3.5	63	220	4.0	
	3	9.5	1.2	3.5	63	215	4.0	
	4	9.2	1.2	3.5	63	200	4.0	
	5	9.5	1.2	3.5	63	210	3.5	
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - GN ₂	1	9.0	1.1	3.5	64	500	97.0	0
	2	8.5	1.1	3.5	64	510	250.0	0
	3	8.5	1.18	3.5	64	500	280.0	0.4
	4	8.5	1.15	3.5	64	510	300.0	0.4
	5	8.3	1.13	3.5	64	510	Failed	0.4
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 5-3. Functional Test Data During a Requested Temperature of 20(+0,-4)°F Specimen 2
(Continued)

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 3000 psig - GN ₂	1						1470 Test Halted	
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 5-4. Functional Test Data at Room Ambient Conditions Following the Low Temperature Test Specimen 2

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing PortC 750 psig - GN2	1	9.0	1.1	3.8	46	58	0	0
	2	9.0	1.0	3.8	46	58	11.25	0
	3	9.0	1.0	3.8	46	58	13.00	0
	4	9.0	1.1	3.8	46	58	12.00	0
	5	9.0	1.1	3.9	46	58	Failed	0
Pressurizing PortC 3000 psig - GN2	1	14.0	0.91	4.0	70	Excessive Time to open	300	Test dis-continued permanently
	2							
	3							
	4							
	5							
Pressurizing Port	1							
	2							
	3							
	4							
	5							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

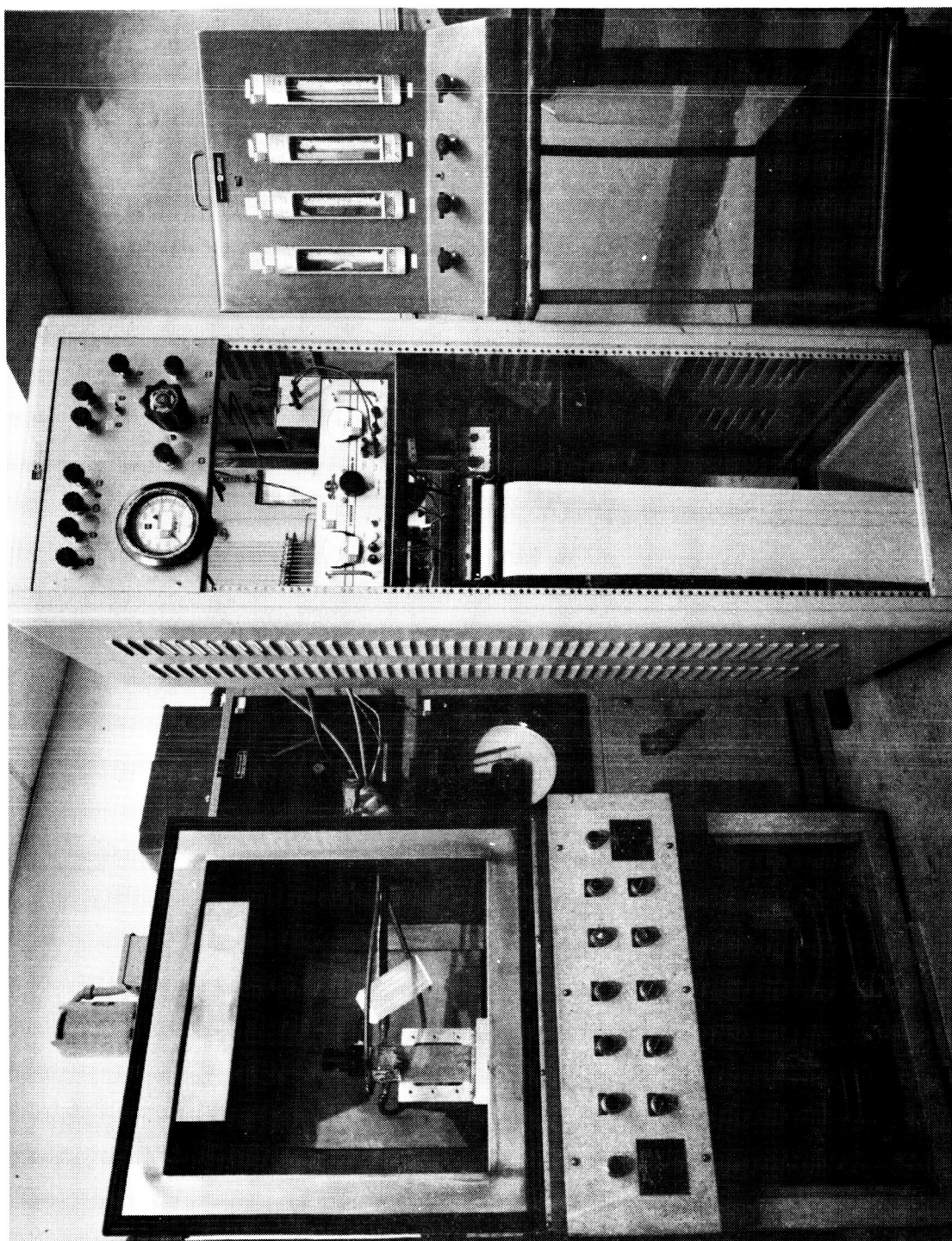


Figure 5-1. Low and High Temperature Test Setup

SECTION VI
HIGH TEMPERATURE TEST

6.1 TEST REQUIREMENTS

- 6.1.1 A high temperature test will be performed on the test specimen to determine whether the environment causes degradation or deformation.
- 6.1.2 The rated high temperature is 160 (+,-0)°F.
- 6.2.3 A functional test shall be performed during this test.

6.2 TEST PROCEDURE

- 6.2.1 The test specimen was placed in a high temperature chamber and the chamber was installed in the test setup shown in figure 4-1 using the equipment listed in table 4-1.
- 6.2.2 A functional test was performed because 72 hours or more had elapsed since the previous functional test.
- 6.2.3 The chamber was controlled at 160 (+5, -0)°F and a relative humidity of 20 (+5) percent was maintained.
- 6.2.4 This temperature was maintained for 72 (+2,-0) hours.
- 6.2.5 A functional test was conducted while the chamber temperature was maintained.
- 6.2.6 The chamber temperature was returned to ambient conditions upon completion of the functional test.
- 6.2.7 The test specimen was visually and functionally tested within 1 hour following the return of the specimen to ambient conditions.
- 6.2.8 All test data were recorded.

6.3 TEST RESULTS

- 6.3.1 Specimen 3 was stabilized at 160°F for 72 hours. With the valve de-energized and with 700, 1500, and 3000 psig applied at port C, leakage rates of 12.5, 2500, and 2660 scim, respectively.
- 6.3.3 All testing was discontinued at this point.

6.4

TEST DATA

6.4.1

High temperature test data are presented in tables 6-1 through 6-3.

Table 6-1. Functional Insulation and Resistance Test Data During High Temperature Test (Specimen 3)

Pin No.	C to D	D to B	C to B	A to C	A to D	A to Housing	B to Housing	C to Housing	D to Housing
Megohms	1.34×10^{44}	1.1×10^4	1.4×10^4	2.8×10^4	7.1×10^5	5.0×10^5	5.0×10^5	Shorted	5.0×10^5
Milliamperes	3.7×10^{-2}	4.5×10^{-2}	3.6×10^{-2}	1.8×10^{-2}	7.0×10^{-4}	1.0×10^{-4}	1.0×10^{-4}	-	1.0×10^{-4}

Table 6-2. Functional Insulation and Resistance Test Data During High Temperature Test Specimen 3

Port	Run No.	Pull in VDC	Current Reading at 24 VDC	Drop Out VDC	Response Time (milliseconds)		Leakage Unenergized (scim)	Leakage Energized (scim)
					Open	Close		
Pressurizing Port C 750 psig - GN ₂	1	15.0	0.98	3.1	43	37	0	0
	2	14.5	0.98	3.0	42	37	1.25	0
	3	14.5	0.98	2.8	43	38	5.00	0
	4	14.5	0.98	2.8	42	37	5.00	0
	5	14.5	0.98	2.8	44	37	12.5 (failed)	0
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 1500 psig - GN ₂	1						230.0	
	2						1500.0	
	3						2000.0	
	4						(failed)	
	5							
	6							
	7							
	8							
	9							
	10							
Pressurizing Port C 3000 psig - GN ₂	1						2200	
	2						2400	
	3						(failed)	
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Allowable response time to open at 3000 psig and 28 vdc: 65 milliseconds

Allowable leakage: 5 scim

Table 6-3. Functional Test Data at Room Ambient Conditions following the Low Temperature Test (Specimen 3)

Pressure psig	Medium	Pressurized Port	Leakage Unenergized	Result
1500	GN ₂	C	300 scim	Failure
3000	GN ₂	C	1250 scim	Failure

Allowable leakage-5 scim

APPROVAL

TEST REPORT

FOR

SOLENOID VALVE, 3/8-INCH, 3-WAY

Flodyne Controls, Inc., Part Number 3A37S

NASA Drawing Number 10425701-2

SUBMITTED BY



G. Collins
Test and Evaluation Section

APPROVALS



R. W. Claunch
Program Supervisor



V. J. Venko, Director
Engineering Department